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**REMARKS**

As an initial matter, Applicants point out that claim 4 is a linking claim linking the claims 7-9 of Group II of the Examiner's restriction requirement (see Office Action, dated December 19, 2002, page 2, lines 2-12) to claims 1-6 of elected Group I. Therefore, when claim 4 is allowed, the restriction requirement must be withdrawn and the claims of Group II rejoined with the claims of Group I. see MPEP 809.

The specification has been amended to reflect that U.S. Patent Application No. 09/401,196 is now U.S. Patent 6,342,333 B1.

Claim 5 is canceled without prejudice, claims 1, 4 and 6 are amended and new claims 10-12 are added.

Specifically, claims 1 and 4 have been amended to recite that the "photosensitive resin composition is selected from the group consisting of (1) a negative-type photosensitive resin composition where the aromatic polyimide precursor comprises a repetitive unit having a monovalent organic group with a carbon-carbon unsaturated double bond on at least a part of side chains of carboxylic acid residues, and (2) a positive-type photosensitive resin composition where the aromatic polyimide precursor comprises a repetitive unit having a group represented by  $-OR^6$  or  $-NH-R^6$  on a least a part of side chains of carboxylic acid residues, provided that  $R^6$  is a monovalent organic group with no carbon-carbon unsaturated double bond" as supported on page 5, lines 25-31, page 11, line 9 to page 12, line 5, and page 19, line 31 to page 20, line 19 of the instant specification, and as supported in parent U.S. Patent 6,342,333, which was incorporated by reference as U.S. Patent Application No. 09/401,196.

Claim 4 has also been amended to incorporate the subject matter of canceled claim 5 and to revise punctuation and form. Claim 6 has been amended to depend upon claim 4.

New claims 10-12 have been added to recite subject matter described on page 19, lines 17-21, page 20, lines 16-19, and page 6, lines 5-13, respectively, of the present specification.

The present amendment adds no new matter to the application.

### **The Invention**

The present invention pertains broadly to photosensitive resin compositions, patterning methods, and electronic components in the semiconductor industry that involve i-line exposure properties. More specifically, in one embodiment in accordance with the present invention, a photosensitive resin composition useful for i-line exposure is provided that comprises an aromatic polyimide precursor, wherein a 10  $\mu\text{m}$  thick layer of the aromatic polyimide precursor has a light transmittance at a wavelength of 365 nm of at least 1%, and a 10  $\mu\text{m}$  thick polyimide film made from the resin composition by imidation ring closure and deposited on a silicon substrate has a residual stress of at most 25 MPa, wherein the photosensitive resin composition is selected from the group consisting of (1) a negative-type photosensitive resin composition where the aromatic polyimide precursor comprises a repetitive unit having a monovalent organic group with a carbon-carbon unsaturated double bond on at least a part of side chains of carboxylic acid residues, and (2) a positive-type photosensitive resin composition where the aromatic polyimide precursor comprises a repetitive unit having a group represented by  $-\text{OR}^6$  or  $-\text{NH-R}^6$  on at least a part of side chains of carboxylic acid residues, provided that  $\text{R}^6$  is a monovalent organic group with no carbon-carbon unsaturated double bond.

In another embodiment in accordance with the present invention, a method for forming patterns is provided which comprises the steps of: (a) applying a photosensitive resin composition onto a substrate and drying; (b) exposing the composition using I-lines as a light source; (c) developing the composition; and (d) heating the composition, wherein the photosensitive resin composition comprises an aromatic polyimide precursor wherein a 10  $\mu\text{m}$  thick layer of the aromatic polyimide precursor has a light transmittance at a wavelength of 365 nm of at least 1%, and a 10  $\mu\text{m}$  thick polyimide film made from the resin composition by imidation ring closure and deposited on a silicon substrate has a residual stress of at most 25 MPa, wherein the photosensitive resin composition is selected from the group consisting of (1) a negative-type photosensitive resin composition where the aromatic polyimide precursor comprises a repetitive unit having a monovalent organic group with a carbon-carbon unsaturated double bond on at least a part of side chains of carboxylic acid residues, and (2) a positive-type photosensitive resin composition where the aromatic polyimide precursor comprises a repetitive unit having a group represented by  $-\text{OR}^6$  or  $-\text{NH-R}^6$  on at least a part of side chains of carboxylic acid residues, provided that  $\text{R}^6$  is a monovalent organic group with no carbon-carbon unsaturated double bond.

Various other embodiments in accordance with the present invention are recited in the dependent claims. The main advantage provided by the various embodiments in accordance with the present invention is that a photosensitive resin composition and a method of forming patterns are provided that utilize polyimide precursors that have increased i-line transparency. The photosensitive resin compositions in accordance with the present invention have low thermal expansion coefficients and a low mechanical stress (i.e., residual stress is at most 25 MPa) when used on a silicone wafer. Furthermore, the photosensitive

resin compositions have a high heat resistance, a high photosensitivity, and a high resolution. In addition, the present invention provides photosensitive resin compositions that are environmentally friendly because they are capable of being developed in an aqueous alkaline solution instead of solvent based developers used in the prior art.

### **The Rejections**

Claims 1-5 stand rejected under 35 U.S.C. 103(a) as unpatentable over Tanaka et al. (EP 0702270 A2) in view of Hagiwara et al. (EP 0738745 A1). Claim 6 stands rejected under 35 U.S.C. 103(a) as unpatentable over Tanaka et al. in view of Hagiwara et al., and further in view of Tanabe et al. (U.S. Patent 6,428,399 B1).

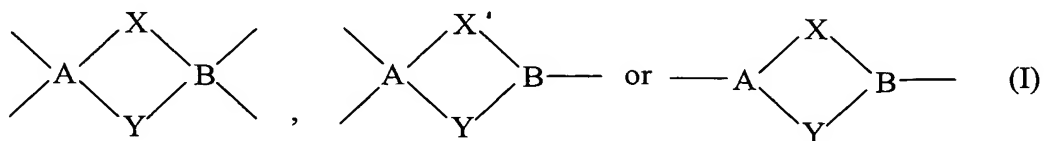
Applicants respectfully traverse the rejection and request reconsideration for the following reasons.

### **Applicants' Arguments**

The Tanaka et al. reference discloses photosensitive resin compositions made with (1) polyamic compounds having, at each terminal end, a specific actinic ray-sensitive functional group that has substituent groups, each having a photopolymerizable carbon-carbon double bond, (2) a photo-sensitive auxiliary having a photopolymerizable functional group, and (3) a solvent (see Abstract). Films formed using the photosensitive resin compositions taught by Tanaka et al. had residual stresses ranging from 18-27 MPa (page 17, lines 16-20, and page 19, lines 44-46).

The Examiner admits that the Tanaka et al. reference does not teach that the polyimide deposited on a substrate would have "a transmittance of at least 5% at a wavelength of 365 nm" as recited in instant claim 2 or that "the light source used for exposure are i-lines" as recited in instant claim 5 (Office Action dated December 19, 2002,

page 3, lines 9-12). Applicants agree that the reference fails to teach these claimed limitations. However, Applicants believe that Tanaka et al. also does not teach, or even suggest, a photosensitive resin composition having a transmittance of at least 1% at a wavelength of 365 nm as recited in claims 1 and 4. In fact, the Tanaka et al. reference is silent with respect to light transmittance. Furthermore, the Tanaka et al. reference teaches polyamic compounds shown in formulas (1) or (2) on page 3 of the reference, and does not teach, or even suggest, that the “photosensitive resin composition is selected from the group consisting of (1) a negative-type photosensitive resin composition where the aromatic polyimide precursor comprises a repetitive unit having a monovalent organic group with a carbon-carbon unsaturated double bond on at least a part of side chains of carboxylic acid residues, and (2) a positive-type photosensitive resin composition where the aromatic polyimide precursor comprises a repetitive unit having a group represented by  $-OR^6$  or  $-NH-R^6$  on at least a part of side chains of carboxylic acid residues, provided that  $R^6$  is a monovalent organic group with no carbon-carbon unsaturated double bond” as further recited in claims 1 and 4. The Tanaka et al. reference also does not teach, or even suggest, the monovalent organic group of the negative-type photosensitive resin composition as recited in claim 10, or the embodiment recited in claim 12 in accordance with the present invention wherein the aromatic polyimide precursor has structural units of the formula (I):



The Hagiwara et al. reference discloses a polyimide precursor having repeating units shown in Formula I-1 of the reference, having an aromatic tetravalent organic group and a divalent diphenyl group (Abstract and page 4). The polyimide precursor disclosed by the

Hagiwara et al. reference is alleged to be particularly suitable for forming patterns using an i-line stepper, and the polyimide precursor can be used in photosensitive resin compositions for forming surface protective films for semiconductor devices or interlaminar insulating films for multi-layer wiring boards (see Abstract). Light transmittance of films formed by spin coating the polyimide precursor of the Hagiwara et al. reference onto a substrate were measured to range from 22-55%, well outside the claimed range, thus teaching against the claimed limitations (page 20, lines 1-6, and Table 2). The Hagiwara et al. reference is silent with respect to the residual stress properties of the films formed using the disclosed polyimide precursor.

The Hagiwara et al. reference also does not teach, or even suggest, a “photosensitive resin composition is selected from the group consisting of (1) a negative-type photosensitive resin composition where the aromatic polyimide precursor comprises a repetitive unit having a monovalent organic group with a carbon-carbon unsaturated double bond on at least a part of side chains of carboxylic acid residues, and (2) a positive-type photosensitive resin composition where the aromatic polyimide precursor comprises a repetitive unit having a group represented by  $-OR^6$  or  $-NH-R^6$  on at least a part of side chains of carboxylic acid residues, provided that  $R^6$  is a monovalent organic group with no carbon-carbon unsaturated double bond” as recited in claims 1 and 4. Furthermore, Hagiwara et al. do not teach, or even suggest, the monovalent organic group of the negative-type photosensitive resin composition as recited in claim 10, or the embodiment recited in claim 12 that has the aromatic polyimide precursor with structural units shown in formula (I).

The Tanabe et al. reference discloses a “polishing apparatus for polishing a hard material-coated wafer” and that 12-inch silicon wafers are known (col. 2, lines 49-50). This

reference discloses a polishing apparatus for polishing a hard material-coated wafer, wherein the hard coat is boron nitride provided by a CVD method. The reference has nothing to do with photosensitive resins in accordance with the present invention.

Any combination of the Tanaka et al. reference, the Hagiwara et al. reference, and the Tanabe et al. reference cannot teach, or even suggest, that the “photosensitive resin composition is selected from the group consisting of (1) a negative-type photosensitive resin composition where the aromatic polyimide precursor comprises a repetitive unit having a monovalent organic group with a carbon-carbon unsaturated double bond on at least a part of side chains of carboxylic acid residues, and (2) a positive-type photosensitive resin composition where the aromatic polyimide precursor comprises a repetitive unit having a group represented by  $-OR^6$  or  $-NH-R^6$  on at least a part of side chains of carboxylic acid residues, provided that  $R^6$  is a monovalent organic group with no carbon-carbon unsaturated double bond” as recited in claims 1 and 4. For this reason alone, the rejection is untenable and should be withdrawn. However, because of the numerous other limitations not taught or suggested by the reference, the Examiner’s rejection thoroughly lacks proper motivation derived from the prior art.

Courts have held that to justify a rejection under 35 U.S.C. 103, it must be shown that (1) the prior art would have suggested to those of ordinary skill in the art that they should make the claimed composition or practice the claimed method (e.g. motivation), (2) the prior art would also have revealed that in so making or carrying out, those of ordinary skill in the art would have a reasonable expectation of success, and (3) both the suggestion and the reasonable expectation of success must be founded in the prior art, and not in the applicants’ disclosure. In re Vaeck, 20 USPQ2d 1438, 1442 (Fed. Cir. 1991).



In the present case, Tanaka et al. teaches photosensitive resin compositions made with polyamic compounds having, at each terminal end, a specific actinic ray-sensitive functional group that has substituent groups, each having a photopolymerizable carbon-carbon double bond, a photo-sensitive auxiliary having a photopolymerizable functional group, and a solvent, wherein films formed using these compositions have residual stresses ranging from 18-27 MPa. No information regarding light transmittance is presented in the Tanaka et al. reference.

The Hagiwara et al. reference teaches photosensitive resin compositions for forming surface protective films for semiconductor devices or interlaminar insulating films for multi-layer wiring boards that utilize a polyimide precursor having repeating units, wherein the repeating units have an aromatic tetravalent organic group and a divalent diphenyl group. The polyimide precursor disclosed by the Hagiwara et al. reference is particularly suitable from forming patterns using an i-line stepper, and the light transmittance of films formed by spin coating the polyimide precursor range from 22-55%. However, the Hagiwara et al. reference is silent regarding low residual stress of these films. Lastly, the Tanabe et al. reference teaches that 12-inch silicon substrates are known.

The prior art references do not suggest to one of ordinary skill in the art to make the claimed compositions, or to practice the claimed method, and the Examiner has not shown that they do. More importantly, there is no reasonable expectation of success contained in the references to justify the proposed combination. Specifically, Tanaka et al. and Hagiwara et al. teach very different precursors and each reference teaches only one of the required claimed properties. Tanaka et al. teach a certain residual stress and Hagiwara et al. teach a certain light transmittance, although the reference does not specifically state at what

wavelength of light the transmittance was measured. If one skilled in the art applied an i-line stepper to the compositions taught by Tanaka et al., there is no indication that the required light transmittance properties would be met. As evident from Comparative Examples 1 and 2 in Table 2 of the Hagiwara et al. reference, a light transmittance of at least 1% is not an inherent feature of photosensitive resins, and is definitely not a feature of the references preferred compounds, so there is no reason to expect that the compositions taught by Tanaka et al. would have the required light transmittance properties.

Furthermore, any mixing of the compositions of the Tanaka et al. reference with the compositions of the Hagiwara et al. reference would produce a final composition with unpredictable light transmittance and residual stress properties. In fact, it is just as likely that one or both of the desired properties would be destroyed by mixing compositions, and less likely that both desired properties would be conserved. For these additional reasons, the proposed combination is untenable and should be withdrawn because there is no reason to expect success.

Applicants emphasize that one of the most important characteristics of the present invention is that the polyimide film has a residual stress of at most 25 MPa as recited in claims 1 and 4, and as described in the instant specification on page 11, line 25 to page 12, line 5. The Tanaka et al. reference discloses a polyimide precursor having a specific structure as shown in Formula (1) or (2) of the reference, and this precursor is used for lowering the residual stress (page 3, lines 26-30). Tanaka et al. discloses that the polyimide precursor has a photopolymerizable group introduced into a side chain of a polyamic acid, and it is additionally taught that such a conventional resin composition has an increased residual stress when it is formed into a film (page 2, lines 23-35 and page 3, lines 12-15).

On the other hand, the present invention includes a photosensitive resin composition comprising an aromatic polyimide precursor having a monovalent organic group on a side chain of a polyamic acid. Therefore, the structure of the polyimide precursor of the present invention is clearly different from the precursor disclosed by Tanaka et al. There is no disclosure in Tanaka et al. that a composition comprising an aromatic polyimide precursor having a monovalent organic group at a side chain thereof has a low residual stress. Likewise, the Hagiwara et al. reference suffers the same deficiency and provides no disclosure regarding a resin composition in accordance with the present invention that would have a low residual stress against a wafer. In summary, the combined disclosures of the Tanaka et al. reference and the Hagiwara et al. reference does not make it obvious to those skilled in the art that a photosensitive resin composition, as defined in presently amended claim 1, would have a low residual stress that is "at most 25 MPa."

Clearly, the only way to achieve the claimed invention is with impermissible hindsight reference to applicants' own disclosure.

### **Conclusion**

The rejection standing against the claims is untenable and should be withdrawn because none of the prior art references teach, or even suggest, the "photosensitive resin composition is selected from the group consisting of (1) a negative-type photosensitive resin composition where the aromatic polyimide precursor comprises a repetitive unit having a monovalent organic group with a carbon-carbon unsaturated double bond on at least a part of side chains of carboxylic acid residues, and (2) a positive-type photosensitive resin composition where the aromatic polyimide precursor comprises a repetitive unit having a group represented by  $-OR^6$  or  $-NH-R^6$  on at least a part of side chains of carboxylic acid


residues, provided that R<sup>6</sup> is a monovalent organic group with no carbon-carbon unsaturated double bond" as recited in claims 1 and 4. Furthermore, there is no prior art evidence that one skilled in the art would reasonably expect the combination of the prior art references to provide a photosensitive resin composition that has residual stress and light transmittance properties recited in claims 1 and 4.

For all of the above reasons, claims 1-4 and 6-12 are in condition for allowance and a prompt notice of allowance is earnestly solicited.

Questions are welcomed by the below signed attorney of record for the Applicants.

Respectfully submitted,

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FORM PTO-1083

Case Docket No. TSUK0004

Date: May 19, 2003

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In re Application of: Akihiro SASAKI et al.

Serial No. 10/012,462

Filed: December 12, 2001

For: PHOTSENSITIVE RESIN COMPOSITION, PATTERNING METHOD, AND ELECTRONIC COMPONENTS

ASSISTANT COMMISSIONER FOR PATENTS

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Sir:

Transmitted herewith is an Amendment in the above-identified application.

- [ ] Small entity status of this application under 37 CFR 1.9 and 1.27 has been established by a verified statement previously submitted.
- [ ] A verified statement to establish small entity status under 37 CFR 1.9 and 1.27 is hereby claimed.
- [ XXX ] No additional fee is required.

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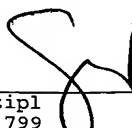
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CLAIMS				HIGHEST NO.		PRESENT		RATE	ADDIT. FEE	OR	RATE	ADDIT. FEE
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TOTAL	*	12	MINUS	**	9	=	0	X 9 = \$			X 18 = \$	
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- [XX] Any filing fees under 37 CFR 1.16 for the presentation of extra claims.
- [XX] Any patent application processing fees under 37 CFR 1.17.

  
\_\_\_\_\_  
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